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Nanotech giving birth to a whole new revolution Budding science will spur flurry of inventions

[Bernadette Tansey, Chronicle Staff Writer](#)

Thursday, May 8, 2003

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URL: <http://www.sfgate.com/cgi-bin/article.cgi?file=/chronicle/archive/2003/05/08/MN171263.DTL>



In the not-too-distant future, your house could be built with strong tiles that heat the rooms with solar power. Inside you could watch a smooth, flat-panel TV with electronic components built right into the glass instead of a web of wires at the back.

Nanosys Inc., a small Palo Alto nanotechnology firm, plans to deliver these and other products within the next three years. Nanosys' inventions arose from the type of industry collaboration with academic labs that Congress has been trying to promote since 2000 through an escalating round of funding for nanotechnology research.

It's the proven formula that has already made the Bay Area a powerhouse in biotechnology and that boosters say could put the region on the forefront of the next industrial revolution - nanotechnology.

Lawmakers who passed a \$2.4 billion authorization bill for nanotech research Wednesday are betting that a new \$1 trillion industry will arise as academic scientists supported by government grants make breakthroughs in basic research that can be mined by private companies for new product ideas.

There's a good chance that a healthy share of those seed grants over the next three years will go to institutions in the Bay Area and California as a whole, where universities already have strong programs in nanotechnology.

If the pattern of biotechnology holds true, those academic research labs will yield scientist-entrepreneurs who will start their own companies; commercial spin-offs based on university patents; and a generation of highly trained nanotechnology workers. In short, a nanotech "cluster."

Nanosys is already building on technology licensed from UC Berkeley, Lawrence Livermore Laboratory and other universities, said Stephen Empedocles, Nanosys' director of business development.

"Government support will help the U.S. stay at the forefront of nanotechnology," Empedocles said. "Countries like Japan are devoting a huge amount of money not only for academic research but for commercial opportunities in nanotechnology."

More powerful computers, cheaper solar power and stronger vehicles are just some of the

nanotechnology products that Bay Area businesses may some day build as the federal government broadens its support for molecular scale technology, academic and industry leaders said Wednesday.

"If you look at the rest of the country, nobody else has the mixture of universities, small companies and established tech giants like Intel and HP working in the nanotechnology arena," said Mark Modzelewski, executive director of the Nanobusiness Alliance in New York.

Among the heavyweight academic players are those old arch-rivals, Stanford and UC Berkeley.

"Nanotechnology legislation is good for UC Berkeley and good for the Bay Area," said Thomas Kalil, special assistant to the chancellor for science and technology. "Berkeley has more than 80 faculty who are doing cutting-edge research in nanoscale science and engineering, great students, top departments in chemistry, engineering, biology and the physical sciences, and the unique proximity of a world-class research university and a national lab (Lawrence Berkeley National Laboratory)."

Nanotechnology is the art of designing products whose molecular structure is precisely defined down to the infinitesimal scale of 1 billionth of a meter,

a tiny fraction of the width of a human hair. At that scale, the properties of matter depart from the physical laws that govern the behavior of bulk materials, yielding the potential for surprising new inventions.

The work draws on the expertise of a broad sweep of academic disciplines like those Kalil named at UC Berkeley and opens the door to new products that range from delicate medical diagnostic instruments to the stain-resistant "nanopants" already on the market.

Nanotechnology funding has already become a fresh arena for the long-standing Cal-Stanford rivalry. The two prestigious institutions are part of different national teams of research institutions competing for a five-year, \$70 million government grant to host training and research centers that would be open to both academic and industry scientists.

Stanford itself already operates such a facility, serving 300 students and as many as 200 small companies that line up to use the expensive fabrication and measurement tools that nanotech research requires.

"Each one (of the small companies) is prototyping some idea they hope to build down the road," said James Plummer, dean of Stanford's engineering school.

Many of those products are years in the future. But the U.S. government has already played a leading role in funding basic research that is still too speculative for many venture capitalists. In 2000, Kalil helped launch the seminal federal effort, the National Nanotechnology Initiative, as then-deputy director of the White House National Economic Council during the Clinton administration.

Although Bill Clinton unveiled the nanotech funding initiative at the California Institute of Technology, California universities have not drawn as many of the grants as would be

expected, given their strong programs in the area, as well as the Bay Area's nearby complement of Silicon Valley firms also active in nanotech R&D, said Modzelewski.

Modzelewski said California institutions at first had not yet seen the need to "package" their interdisciplinary efforts as "nanotechnology" and lobby for the grants.

But with Congress' expanded commitment to nanotech, California institutions are now becoming serious contenders, he said.

"You're looking at some very strong programs that will be able to attract those funds," Modzelewski said.

Hewlett-Packard spokesman Dave Berman said the company was investing in nanotech research to try to sustain the steady gain in computing power the industry has maintained for four decades. The limits of silicon technology will slow the pace of those gains within a decade.

"Hewlett-Packard is investing in alternative technologies that effectively will reinvent the computer," Berman said.

Plummer said the government had been pursuing the best possible tactic by distributing nanotech funds in hundreds of small grants to innovative researchers throughout the country, instead of focusing the money on a small number of nanotech applications. He said the potential of nanotechnology reached into every area of product development.

"Casting lots of seeds on the ground is the right strategy," he said. "I don't think we really know where the big payoff will be."

E-mail Bernadette Tansey at btansey@sfchronicle.com.

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